TOP SECRET

[redacted] 25X1

Copy 1

3 July 1963

MEMORANDUM FOR: The Director of Central Intelligence

SUBJECT : Panel for Future Satellite Reconnaissance Operations

1. The Panel which you appointed to consider questions related to the future satellite reconnaissance program has concluded its study, and I am transmitting herewith our Report. May I say at the outset that the group of Panel members and consultants over which you asked me to preside was an extremely well-informed, thoughtful, and conscientious group. I want to express my personal gratitude to the Panel members and consultants, and also my appreciation for the excellent staff support with which we were provided.

2. I know that you appreciate that time was a severely limiting factor. Because our study had to be compressed into so short a period, we had to limit the number of questions we could come to grips with. Within these limitations, however, I think the Panel has examined carefully and objectively the major questions you set before us.

3. The Panel had two full day meetings on 4 and 5 June which were preceded by special briefings of some of the members. Our Report has gone through several stages of drafting in the course of which the Panel members were consulted, individually or in small groups. Except for very minor editorial changes our Report, as submitted herewith, has been reviewed by all Panel members, who concur substantially in its findings except where specifically noted to the contrary in the Report itself.

4. In behalf of the Panel members and consultants, I wish to express our appreciation of the privilege and responsibility you have

25X1

[redacted]

TOP SECRET

25X1

assigned to us in calling on us to serve in this way. It is our sincere hope that our counsel, in some way, will benefit the work of the Intelligence Community.

SIGNED

25X1

Chairman
Reconnaissance Panel

ATTACHMENT TO

[redacted] 25X1

25X1 [redacted] PANEL

REPORT

[redacted] 25X1

ATTACHMENT TO

[redacted] 25X1

MEMBERSHIP

25X1 [redacted] Chairman

Dr. Allen F. Donovan

25X1 [redacted]

Dr. Arthur C. Lundahl

CONSULTANTS

25X1 [redacted]

[redacted] 25X1

ATTACHMENT TO

[redacted] 25X1

25X1 [redacted] PANEL REPORT

TABLE OF CONTENT

[redacted] 25X1

ATTACHMENT TO

25X1 [redacted]

25X1 c. [redacted]

d.

25X1 e. [redacted]

10. A-12 DRONE

11. SUMMARY OF OUR MAIN CONCLUSIONS

25X1 [redacted]

ATTACHMENT TO

[redacted]

25X1

1. INTRODUCTION

In response to a request from the Director of Central Intelligence, the Panel was assembled to examine some broad problems in satellite reconnaissance. The Panel addressed itself to the following questions:

a. What is the capability of existing and programmed systems to provide photographic coverage of the quantity and quality required to meet future intelligence requirements?

b. What are the technical possibilities for the future development of satellite photography, and how should these affect systems planning and research?

c. What should be the technical goals in the next phase of development?

d. What is the vulnerability of our systems to counter-measures; how serious is the threat, and what steps should be planned to meet it?

In addition to these central questions, the Panel considered a number of proposals and ideas for special systems. Finally, although the Panel did not undertake a study of the A-12 airborne system as such, its importance in the whole picture was very much in our minds. The capabilities and the complementary roles of airborne and satellite systems were compared at relevant points.

To state our problem even more briefly, we tried to look into the future to see how far satellite reconnaissance may reasonably be expected to develop in the service of our intelligence needs, and what work needs to be done to insure that it develops as rapidly as possible in the right directions. It is obvious that so short a study had to leave many important problems untouched.

ILLEGIB

[redacted]

25X1

Next 1 Page(s) In Document Denied

25X1

ATTACHMENT TO [redacted] 25X1

to all films and cameras; nor need it measure any precisely defined theoretical parameters. It need not even relate closely to the military specification involving bar targets, but it must be applicable routinely and simply to any segment of useful M negative. Possibly a simple measurement of something related only to the cut-off of the spatial-frequency power spectrum in the final negative can be devised. If it can be diagnostic, so much the better, but the overriding need is for an unambiguous quality control test.

This "product improvement" program for M presents a really golden opportunity, not a thankless chore. If carried through in the spirit, with determination, its quantitative yield in intelligence information may surpass that of any single more advanced system we could now design. 25X1

[redacted]

[redacted] 25X1

SECRET

ATTACHMENT TO [redacted] 25X1

4. PLANNING BEYOND CURRENTLY PROGRAMMED SYSTEMS

25X1 The [redacted] is an example of a bold step in what we would think is generally the right direction, that is, in pushing reso-
25X1 lution to the limit even at some expense in coverage. Actually, as now conceived, the [redacted] with its considerable flexibility would offer substantial coverage in some modes. We feel, however, that it is a little too early to freeze the concept of the next advanced system. The reasons for this are the following: in the current state of the art, as was convincingly demonstrated by the excellent parametric studies presented to us, the controlling parameters of film speed, film resolution, vehicle attitude stability, and the laws of wave optics, lead one to a compromise in which size, weight and complexity of the instrument are affected by even a modest change in a basic parameter. One can almost say that a modest factor in film speed could mean the difference between a thrust-augmented THOR and a TITAN for the transporting vehicle. In other words, in the next generation of reconnaissance cameras it will be even more important than before, if that is imaginable, to take the utmost advantage of every advance in optical materials and techniques. In the following section, we discuss some possibilities for technological advances which can probably be evaluated soon enough so that one can estimate their importance for the coming generation of systems. In a few months' time, it may be possible to see much more clearly than now what kind of system we ought to go for.

25X1 [redacted]

ATTACHMENT TO [redacted] 25X1

5. TECHNOLOGICAL ADVANCES

a. Emulsion Properties

Current camera designs, when optimized, turn out to be an expression of the properties of the SO-132 emulsion. Within limits at a given state of the emulsion art, there is a trade off between sensitivity and resolution which can be manipulated to get better results in a particular context. On the other hand, it appears not unreasonable to hope for some absolute improvement in emulsion properties which would yield a faster film at the same resolution or its equivalent. Probably a factor of 4 in speed for a given resolution is too much to hope for, but we have some confidence that a factor of 2 may be obtainable. This would be an extremely significant gain, which would of course be welcome in our current systems. It could be immediately exploited in the design of new systems to alter materially the weight-size-stabilization requirements in the next generation of instruments. Within a few months one may know whether such an improvement in emulsions can indeed be anticipated. We think it extremely important that this question be pursued.

b. Image Intensifiers

The electronic image intensifier is a device which is now being developed vigorously in a number of forms. It may possibly present an opportunity for a major breakthrough in satellite photography. In the image intensifier, light from the original scene falls on a photo-cathode rather than on the film directly. The electrons ejected from the photo-cathode are accelerated to bombard the phosphor, where they make more light. This light can then expose a photographic film or the process can be cascaded to make more electrons, more light, etc., until at some stage photographic recording occurs. It remains to be seen whether the required resolution in lines per millimeter can be maintained. There is no fundamental reason why it cannot be. Some preliminary calculations suggest that several hundred lines/mm is not out of the question. Indeed, in the application to satellite cameras, we appear to have a situation peculiarly favorable to the application of the image-intensifier technique. In most of the current and future designs the light is

25X1 [redacted]

recorded at any given instant along a narrow strip or slit, a geometry highly advantageous for control of the electron trajectories. This technique may permit the further flexibility of recording photographically at a scale different from that of the primary image. We recommend that the possibilities of image-intensifier techniques be immediately investigated. If closer investigation corroborates our present optimism, a vigorous program of development should be started. Here, too, we expect that a few months' study could give us a very much clearer picture of the implications for planning of our future systems.

c. Very Large Optics

Advances in the design of very large optical systems are continuing to be made. These include not only new geometrical arrangements of reflecting surfaces, correcting plates and lenses, but also new techniques for constructing large mirrors that are accurate but not enormously heavy. It is reasonable to contemplate apertures at least as large as 60" diameter operating, so far as their intrinsic optical performance is concerned, close to the "diffraction limit" set by the wave length of light. To be more specific, it appears that a 60" diameter f/2 system forming a good image on a 10" slit is entirely feasible, as is a 40" diameter, f/1.5 with a 6" slit. If and when we move into larger vehicles, it is these larger systems we should be thinking about. It is not too early to support research and development on components, in view of the fact that the lead time on the very large optical elements involved may be as much as two or three years. (Of course we must not forget that the lead time on launching facilities may be another critical element in the utilization of larger vehicles.)

The impression gained from our discussions of these larger optical systems is that bulk is likely to be a more stringent limitation than weight, especially if the development of large beryllium mirrors continues to proceed as successfully as it has to date.

d. Stabilization

The problem of vehicle stabilization is likely to remain with us in spite of all optical inventions and will grow more acute rather than

ATTACHMENT TO

[redacted] 25X1

less. Hence, there will be a continuing need for innovation and ingenuity in the development of vehicle stabilization techniques appropriate to the camera platform. Some degree of image stabilization (as contrasted with vehicle stabilization) may be possible in some of the new optical systems, including the hypothetical image-intensifier system just mentioned.

[redacted] 25X1

ATTACHMENT TO

[redacted]

25X1

6. EVENTUAL LIMITS OF RESOLUTION

There is no evidence that our present systems are running into any fundamental limitations on ground resolution. Of course, the inexorable relation between angular resolution and lens diameter does impose an ultimate lower limit on the size of our instrument. It takes a 10 inch aperture to resolve a foot at 100 miles if everything else is perfect. Probably one can push as far as one foot ground resolution without severe trouble from the atmospheric medium. The question remains as to where the inhomogeneity of the atmosphere will make itself evident, preventing any further useful advances. On this question we have no conclusive experimental evidence. The astronomers are familiar with the inverse problem of seeing up through the atmosphere, but their experience does not necessarily provide the answer. We are also unable to predict at present whether this eventual limitation will be relatively more or less serious for the satellite borne camera than for an airborne camera. As we advance into a new domain of performance this fundamental question will deserve serious research attention. In advance of empirical tests, we may well be able to draw useful conclusions from calculations for various models of a turbulent atmosphere.

Satellite systems are completely free from one problem which may eventually limit the resolution of airborne cameras, the optical irregularities in the airstream adjacent to the vehicle. Where this limit will set in, for airborne systems, is an open question at the moment, but tests in the actual environment which are now scheduled should provide a reliable answer, at least for ground resolution of the order of one or two foot. This problem, if it ever becomes serious, is perhaps not entirely beyond remedy.

[redacted]

25X1

Next 1 Page(s) In Document Denied

ATTACHMENT TO

[redacted] 25X1

8. READ-OUT SYSTEMS

The Panel considered rather briefly the current status of developments in read-out systems. This technique has, of course, had a long history of development. The original technical objectives were met; we know that read-out can work, but there has been no practical application to reconnaissance. The basic limitation of present read-out systems is still imposed by the radio frequency channel capacity and the read-out time available, and this handicap has grown, if anything, relatively more discouraging in comparison with photographic recording and recovery. A constant which pretty well characterized read-out systems was stated in the following form: one or two square inches of picture per megacycle band, per minute, for a picture with 100 lines per millimeter resolution. One can perhaps invent missions aimed at quick recovery of 1 or 2 pictures of a few small targets which would make a read-out system attractive, but these would have to be compared with what we might do by a quick-reaction satellite with recovery, or by other means, such as a [redacted] 25X1

25X1 [redacted]. On the whole, we can generate very little enthusiasm for the read-out technique. Some research in this area might reasonably be kept going. In particular, new means should be sought to expand the capacity of the over-all film-to-ground channel by ultra-fast scanning techniques and very wide band communications. But we conclude that there are no evident opportunities in read-out systems which ought to affect our major plans for further development and use of photographic systems with recovery.

ILLEGIB

[redacted]

ATTACHMENT TO

[redacted] 25X1

9. SOME SPECIAL SYSTEMS AND MISSIONS

The Panel considered briefly a number of special systems; some are already under study, others may warrant examination.

a. Quick Reaction Satellite. Clearly our present capability for prompt acquisition of important photographic intelligence is limited, not so much by the recovery cycle, as by the lead time involved in the launching of a previously unscheduled flight. The Panel shares the rather obvious view that something ought to be done about this and that in addition to the general streamlining of the launching operations, which is a problem already being attacked on other fronts, the possibility of a specially planned quick reaction vehicle should be studied. Whether this is feasible or not will have an important bearing on the relative utility of such other means as readout satellites and drones. 25X1

[redacted]

ILLEGIB

25X1

Next 1 Page(s) In Document Denied

ILLEGIB

ATTACHMENT TO

[redacted]

25X1

II. SUMMARY OF OUR MAIN CONCLUSIONS

Returning to the central questions from which we began, we find emerging from our discussions a few important conclusions. First, the M system itself, successful as it has been, still holds great potential for better work and more return. We cannot emphasize too strongly the importance of this opportunity. Second, the technological possibilities for growth in the direction of higher resolution systems are extremely promising. The eventual goal of ground resolution approaching one foot is not too high for optical photography to aim at. Third, there is a good chance that a new technique developed around the electronic image intensifier can greatly widen the technical possibilities for photography from satellites. With these prospects before us, we may clearly look forward to an extremely active enterprise in this area.

The compact and competent management organization, under which the present operational systems were developed, we believe, has contributed largely to the past success of the program. The Panel did not consider at this time the effect of recent changes in the management structure. It recommends, however, that this subject be continually reviewed to ensure that the clearness of focus and purpose originally achieved, has not been diffused.

ILLEGIB

[redacted]

25X1

DELETED PAGES FROM [redacted] PANEL REPORT [redacted]

25X1

ATTACHMENT TO

25X1 [redacted]

25X1

[redacted] PANEL REPORT

TABLE OF CONTENT

TOP SECRET

ATTACHMENT TO

[redacted] 25X1

25X1

c [redacted]

d

25X1

e. [redacted]

10. A-12 DRONE

11. SUMMARY OF OUR MAIN CONCLUSIONS

25X1

[redacted]

25X1

25X1
25X1

ILLEGIB

ATTACHMENT TO

[redacted]

25X1

9. SOME SPECIAL SYSTEMS AND MISSIONS

The Panel considered briefly a number of special systems; some are already under study, others may warrant examination.

a. Quick Reaction Satellite. Clearly our present capability for prompt acquisition of important photographic intelligence is limited not so much by the recovery cycle, as by the lead time involved in the launching of a previously unscheduled flight. The Panel shares the rather obvious view that something ought to be done about this and that in addition to the general streamlining of the launching operations, which is a problem already being attacked on other fronts, the possibility of a specially planned quick reaction vehicle should be studied. Whether this is feasible or not will have an important bearing on the relative utility of such other means as readout satellites and drones.

ILLEGIB

[redacted]

ILLEGIB

ATTACHMENT TO

[redacted]

25X1

1. INTRODUCTION

In response to a request from the Director of Central Intelligence, the Panel was assembled to examine some broad problems in satellite reconnaissance. The Panel addressed itself to the following questions:

a. What is the capability of existing and programmed systems to provide photographic coverage of the quantity and quality required to meet future intelligence requirements?

b. What are the technical possibilities for the future development of satellite photography, and how should these affect systems planning and research?

c. What should be the technical goals in the next phase of development?

d. What is the vulnerability of our systems to counter-measures; how serious is the threat, and what steps should be planned to meet it?

In addition to these central questions, the Panel considered a number of proposals and ideas for special systems. Finally, although the Panel did not undertake a study of the A-12 airborne system as such, its importance in the whole picture was very much in our minds. The capabilities and the complementary roles of airborne and satellite systems were compared at relevant points.

To state our problem even more briefly, we tried to look into the future to see how far satellite reconnaissance may reasonably be expected to develop in the service of our intelligence needs, and what work needs to be done to insure that it develops as rapidly as possible in the right directions. It is obvious that so short a study had to leave many important problems untouched.

ILLEGIB

[redacted]